TIDAL BOUNDARY DELIMITATION: SOME NORTH AMERICAN PERSPECTIVES

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ABSTRACT

The recent trend in tidal boundary delimitation has been to replace traditional survey methods, where the boundary is interpreted as a physical mark on the shore, by more precise definitions and surveys referenced to a tidal datum. Some of the coastal land tenure issues that have contributed to this trend in North America are highlighted in this paper. Major changes in tidal boundary delimitation have taken place in recent years in the United States, but to date new methods have had sporadic application in Canada. Therefore, both conventional surveys and methods based on tidal datums are evaluated. General requirements for precise surveys using tidal datums are derived from the North American experience. Emphasis has been given throughout to high water boundaries, which define the seaward extent of private land tenure in most Canadian and American jurisdictions.

1. INTRODUCTION

The tidelands of North America represent a very diverse range of physical, socio-economic and historical characteristics. They encompass large tracts of beaches and marshlands, harbour fronts of major cities and inaccessible wilderness, regions of extensive erosion and lands rapidly rising from the sea. Nearly every type of tidal regime can be found, including tides with ranges of up to 16 metres. The laws affecting private and public rights to tidelands are derived from England, France and Spain, as well as from customary tenure and many levels of subsequent judicial authority. Almost as diverse are the tidal boundaries that mark the extent of rights and the methods of surveying those boundaries.

In the last four decades, tidelands have become inundated by ownership and boundary problems. More intensive use of coastal regions, together with increasing state intervention, have led to new legislation and wide sweeping coastal programs. These reforms have sometimes caused, as well as responded to, multi-million dollar litigation. Since tidal boundaries are frequently a central issue, the definition and the survey of these boundaries have come under critical review. To date most of the litigation, debate and reforms have been confined to the United States. Much less concern has been expressed in Canada, despite the existence of similar land tenure and survey problems.

Since the law and survey regulations affecting coastal areas differ in each state and province, this paper only provides an overview of the North American situation, with selected examples from Canada and the United States. In evaluating both traditional and modern tidal boundary survey methods, emphasis is given to high water boundaries. Some of the land tenure issues that have led to a quest for greater survey precision at the land-water interface are highlighted and general requirements for achieving this precision are discussed.

2. COASTAL LAND TENURE: TRENDS AND ISSUES

Over 50% of Canadians and Americans live in states and provinces bordering three oceans and the Great Lakes. The intensification and diversification of coastal land use in recent years has resulted in new land tenure and resource issues. Consequently, North American governments at all levels have begun to assume a more prominent role in the management of coastal lands.

The role of the state or Crown as protector of the public interest in tidelands has its roots in both the civil and common law. In North America, this role has been directly influenced by the 17th century writings of Sir Matthew Hale. Attempting to resolve a long standing dispute in England over the extent of private rights, Hale argued in his treatise *De Jure Maris* (c. 1666-67) that the limit between private and Crown ownership in tidal waters was *prima facie* defined by the *ordinary or neap high tides.*[1] Below this limit, although private rights may exist, tidelands are subject to public rights entrusted to the Crown.

Although this *jus publicum*, or public trust doctrine, has always been recognized as a fundamental feature of coastal land tenure in North America, the balance between public and private rights varies. In every state and province, some private rights to tidelands have been acquired through grant or customary useage. Several states have enacted new laws to prevent further tideland grants and, in most jurisdictions today, leases and permits for development or acquaculture are the primary means of allocating tidelands. Even where private rights exist, the right to exclude other users is usually limited. Private rights are universally subject to the public right of navigation and the general trend in both countries is expansion, or at least better protection, of public rights.[2]

Examples of specific coastal management concerns that have led to boundary issues in recent years include the following:

A. Public Access: With the increasing value of tidelands as recreational and aesthetic areas, there have been conflicts of interests between private owners and the general public. Public access to beaches and to the dry sand areas above high water has become a major concern. Remedies have included implied or express easements, dedication of public areas in new development plans, and expropriation.[3] For example, in Oregon, the 1967 *Beach Law* provides for a public easement over private lands seaward of a line that is located 16 feet (4.9 m) above the National Geodetic Vertical Datum (MSL) and approximates the limit of vegetation.[4]

B. Environmental Protection: Vast tracts of wetlands have been subject to reclamation by upland owners for development. In attempts to delimit boundaries to protect environmentally sensitive areas, wetlands have frequently become battlegrounds for state authorities, surveyors, and private landowners. The State of New Jersey, for example, defined limits of private rights in wetlands by *biological boundaries* (variations in vegetation) which differ appreciably from surveyed boundaries based on tidal datum information. As these claims have involved valuable real estate, litigation has been extensive.[5] Similar descrepancies in marshland surveys for an expropriation in the

[1] Hale, M. [c. 1666-67]. *De Jure Maris*; as reported in Shalowitz, A. L. [1962]. *Shore and Sea Boundaries*, Vol. I. Publication No. 10-1, Coast and Geodetic Survey, U.S. Department of Commerce, Washington, DC, p. 91.

[2] anon. [1970]. The public trust in tidal areas: A sometimes submerged traditional doctrine. *Yale Law Journal*, 74, pp. 762-788.

[3] See, for example, Curtis, J. D. [1981]. Coastal recreation: legal methods for securing public rights in the seashore. *Maine Law Review*, 33, pp. 69-102; Littman, A. N. [1977]. Tidelands: trusts, easements, custom and implied dedication. *Natural Resources Lawyer*, 10(2), pp. 279-296; Maloney, et al. [1977]. Public Beach Access: A guaranteed place to spread your towel. *U. of Florida Law Review*, 29, pp. 853-880. For an example of Canadian legislation see *Beachs Preservation and Protection Act*, Statutes of Nova Scotia [1975], c. 6.

[4] Oregon Revised Statutes s. 390.605; as reported in Graber, P. H. F. [1982]. The law of the coast in a clamshell, Part VIII: The Oregon approach. *Shore and Beach*, 50(3), pp. 16-23.

[5] See, for example, Tell, L. [1982]. A tidal wave of claims. *The National Lawyer*, July 12, pp. 1-3.; Porro, A. A. Jr. and J. P. Weidener [1978]. The mean high water line: Biological vs. conventional methods—the New Jersey experience, *Proceeding of the Annual Convention of the ACSM*, Washington, DC, February, 1978; Porro, A. A. Jr. [1970]. Invisible boundary—private and sovereign marshland interests. *Natural Resources Lawyer*, 3, pp. 512-520.

D. Accurate, Up-to-Date MHW Reference Elevations: Since the accuracy of MHW elevations determined at survey sites will depend on the accuracy of the reference station elevations, the latter should be based on long tidal series (e.g., minimum of one month) whenever possible. Furthermore, provisions must be made to update elevations to account for long term trends in sea level. For cadastral surveys, elevations should also be referenced to geodetic datums rather than, or in addition to, chart datum.

E. Provision of an Information Support Service: Surveyors must have ready access to survey-related information to support MHWL surveys. Besides tidal datum elevations, this information should include tidal station locations, ties to and locations of survey control monuments, information regarding temporary stations and datums established in nearby areas by other surveyors, and all relevant charts, maps, photos, and plans. The collection, storage, and distribution of such information on a state wide basis is an integral part of the Florida Coastal Mapping Program.[39]

F. Implementation of Appropriate Survey Standards: Professional survey associations must address the question of consistent standards for tidal boundary definitions, ground and aerial survey methods, tolerances, and survey plans. Examination of surveys may also be a consideration. Efforts should also be made to include all surveys within the survey standards for consistency (including those conducted in the jurisdiction by nonprofessional government agencies and by, for example, federal surveyors).

G. Continuing Education: To provide current and future surveyors with the knowledge and skills required for precise surveys, education curriculums should include tidal boundary delimitation methods and relevant coastal hydrography. The survey profession should also provide seminars and other means to keep their members abreast of new methods. Since the legal profession and other groups, such as hydrographers, planners, and land administrators, may be directly affected by changes, communication forums are recommended to identify potential problems before changes are made and to provide information to these groups.

Any jurisdiction considering adoption of MHWL survey methods must meet at least two other requirements. There should first be an assessment of the need for changes in conventional methods. The establishment of accurate tidal datums for surveys will involve extensive costs to government, surveyors, and clients. Therefore, *the need for changes must be well recognized by all concerned.* If problems or potential benefits are sufficient to justify improved survey methods, then *there must also be on-going commitment* on the part of government and the survey profession in meeting the other requirements for MHWL surveys.

7. SUMMARY

In the United States, there has been a need for improved tidal boundary surveys. A new emphasis on coastal resource management and increasing conflicts of interest between private owners and the state have led to what one author has referred to as "a tidal wave" of boundary disputes.[40] The *Borax* decision set the precedent for new definitions and survey methods. Since coastal real estate valued at billions of dollars would be affected by differences of even several centimetres in establishing tidal datums for boundary surveys, the survey profession and government agencies have begun systematic programs for improving tidal data and survey methods.

Canada, on the other hand, has not yet experienced extensive litigation or survey problems. Although coastal land tenure is similar to that in the United States, the pressures of coastal development and intensive land use are more localized. OHWM

[39] *Supra*, reference 36.
[40] Tell [1982], *supra*, reference 5.

partial tidal cycles can be used at the survey site, thus facilitating marshland surveys. In the United States, these methods have also been used to provide extensive, consistent coastline surveys based on tide controlled aerial photography.

The major limitation of precise datum transfers is that cadastral surveyors must make tidal observations which require at least one to two days on the the site, additional equipment (tide staff or gauge), and expertise in the various methods and calculations. Furthermore, it is estimated that with one day of observations, the datum elevation can only be established with an accuracy of approximately ± 0.076 metres[35] (e.g., resulting in a boundary displacement of ± 1.52 metres on a 5% gradient). Thus, the precision of the survey is in some cases an illusion.

While MHWL surveys have become accepted in many jurisdictions as standard survey practice, the degree to which the boundaries so delimited represent the "true MHWL" will depend on the method chosen, the particular tidal and coastal regimes of the area, and the quality of reference station tidal data available to the surveyor. If supported by appropriate survey standards, however, MHWL surveys can provide a more consistent approach to tidal boundary delimitation than OHWM surveys. Perhaps more importantly, the MHWL is generally a better representation of the limit of the mean, medium, or average high tides than most physical marks on the shore.

6. REQUIREMENTS FOR PRECISE MHWL SURVEYS

Recognizing that the trend in tidal boundary delimitation is towards MHWL surveys, this section outlines some of the requirements for implementing or improving these surveys. For the most part, the following requirements are derived from coastal boundary programs in the United States, in particular Florida's coastal mapping legislation,[36] and experience in Canada.

A. Legally Recognized MHWL Definition: A consistent and precise definition of the tidal boundary should be used in all legislation and legal references. While American jurisdictions have recognized the boundary definition in *Borax*, Canada has no such direct standard. Thus, terminology varies in case law, in legislation, and survey practice and adds to the confusion in methodology.

B. Standard Definition of MHW Datum: While most jurisdictions have defined tidal datums for charting and navigation, tidal boundary surveys often require new datum definitions. Standard MHW and MLW datums have been defined in the United States and have legal recognition.[37] But American definitions based on tidal observations and 19 year tidal epochs (for updating datum elevations) cannot, for instance, be adopted in Canada without changes in the collection and analysis of tidal data.

C. Densification of Tidal Station Networks: In most countries, such as Canada, tidal station networks have been established for charting. Existing stations are generally insufficient to support MHWL surveys and often are not located in areas where survey problems are most common. Under a federal-state cost sharing arrangement, American states have started to densify station networks for cadastral surveys. In Florida, for example, the establishment of 800 new primary, secondary, and tertiary stations along 17,700 kilometres of coastline began in 1969.[38]

[35] Weidener, J. P. [1979]. Surveying the tidal boundary. *Surveying and Mapping*, 39(4), p. 338; Swanson, R. L. [1974]. *Variability of Tidal Datums and Accuracy in Determining Datums for Short Series of Observations*. NOAA Technical Report NOS 64, National Ocean Survey, National Oceanic and Atmospheric Administration, U.S. Dept. of Commerce, Washington, DC.

[36] *Florida Coastal Mapping Act of 1974* [1974], Florida Statutes, C. 177.

[37] *Supra*, reference 30.

[38] *Supra*, reference 21.

shore. On steep slopes, the MHWL can be determined within a small margin of error based on an approximate MHW datum elevation. But to delimit boundaries at acceptable survey standards in marshlands and tidal flats with relatively gradual slopes (often 10% gradient or less), the MHW elevation must be established to within centimetres at the survey site. For this reason, attention has been given in recent years to precise methods for transferring tidal datums from reference (control) stations for MHWL surveys. (See, for example, O'Hargan,[31] Weidener,[32] Grant and O'Reilly.[33])

To illustrate some of the problems encountered by both Canadian and American surveyors in delimiting MHWL boundaries, the various methods that have been developed have been classified below as those which are a function of elevation (*contour*), a function of time (*observed water level*), or a function of both time and elevation (*simultaneous comparisons*).

A. Contour at a Fixed MHW Elevation: The MHWL is sometimes delimited as a contour along the shore at the MHW datum elevation as established at a tidal reference station in the vicinity of the survey site. In this case, the tidal datum is assumed to be a flat, level surface between the station and the site, whereas tidal datum elevations can, in fact, vary significantly even over relatively short distances. Variations in local datum elevations can be caused, for example, by the configuration of the coast and seabottom and such features as vegetation and wharves. A dense network of tidal stations and/or interpolation of elevations between tidal stations can reduce, but not eliminate, the inherent inaccuracies of this method.

B. Observed Waterline at the Predicted Time of MHW: Another method of establishing the MHWL is to demarcate the observed waterline at the survey site at the time MHW is predicted to occur. While this method accounts for spatial variations in datum elevation, it has three primary drawbacks.[34] If the survey is based on the time of MHW predicted at a reference station, or even an interpolated time for the survey site, daily fluctuations in water level due to meteorological conditions and the local variations in the progression of the tides along the coast can result in horizontal displacements of the MHWL. Secondly, where wave action is extensive, locating a waterline is at best a guess. A third consideration is that where the water line changes rapidly (e.g., on tidal flats or where there is a large tidal range), stakes must be placed almost simultaneously along the entire boundary line before the water level rises above or recedes below MHW in order to obtain the true MHWL.

C. Simultaneous Comparison of Tidal Observations: The preceding methods assume no tidal data is collected at the survey site to establish either the elevation or time of MHW. Methods now being used by American surveyors, in which simultaneous tidal observations at the survey site and a nearby tidal reference station are compared to establish the MHW datum, have been designed to provide a more accurate boundary delimitation. By taking observations at the survey site, reference station data can be corrected for local variations in the elevation and/or time of MHW. Once the MHW elevation has been established, the boundary can either be delimited as a contour at that elevation for short distances or as the observed waterline when the MHW elevation is reached on a tidal staff at the site. Basically, these methods are variations on datum transfers for hydrographic surveying, such as the range-ratio method. In some cases,

[31] O'Hargan, P. T. [1972]. Demarcation of tidal water boundaries. *Proceedings of the ACSM*, Washington, DC, March, 1972, p. 1.

[32] Weidener, J. P. [1982]. Seeking precision in the ebb and flow of tidal boundaries. *Professional Surveyor*. March/April, pp. 28-33.

[33] Grant, S. T. and C. T. O'Reilly [1986]. A new look at tidal datum transfers. *Papers of the XVIII International Congress of Surveyors (FIG)*, Vol. 4, Toronto, Ontario, June, 1986, pp. 259-280.

[34] These were issues in *Irving Refining Limited and the Municipality of the County of Saint John v Eastern Trust Company* [1967] 51 A.P.R. 155 and are discussed in Nichols, S. E. [1983], *supra*, reference 6.

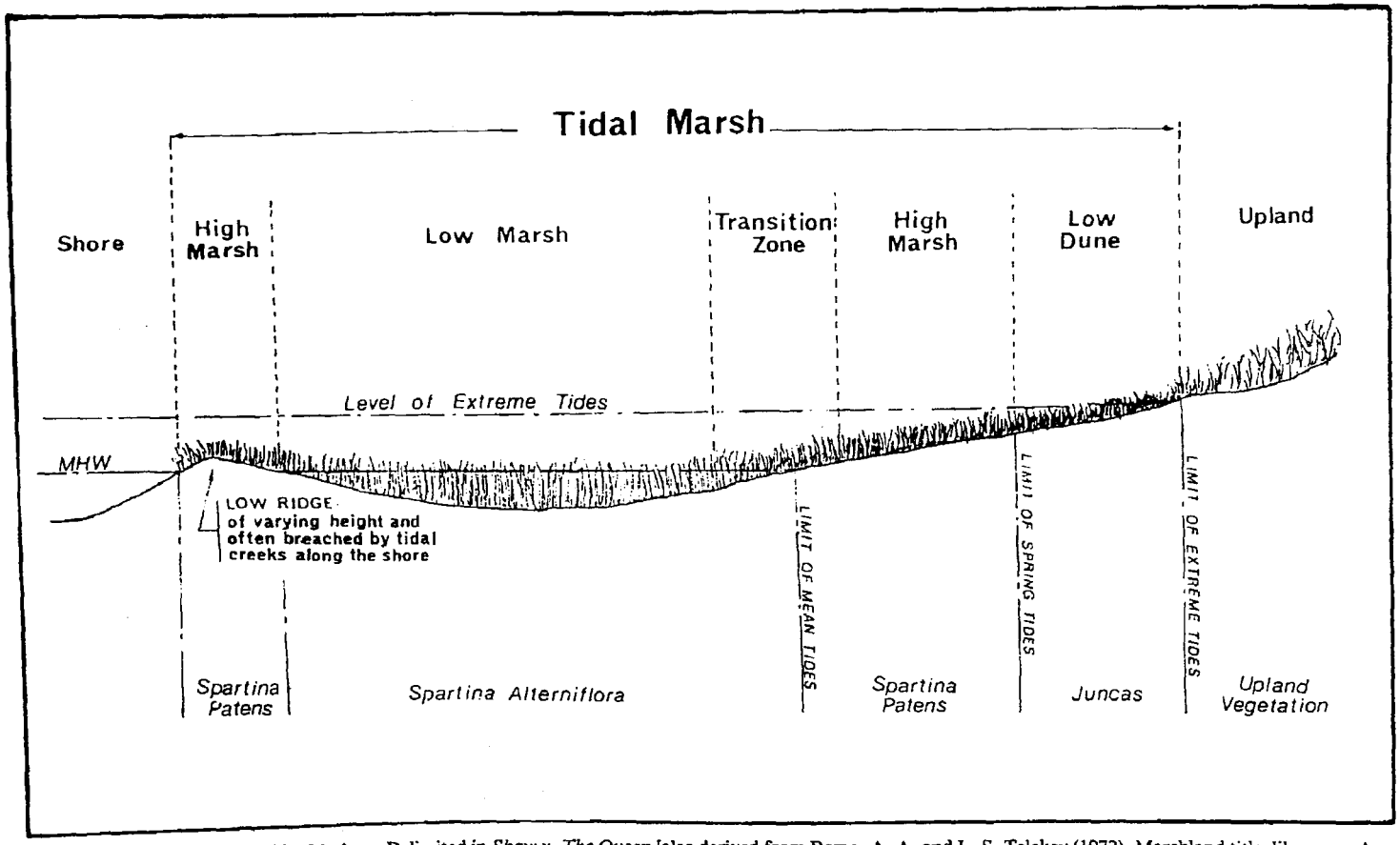

Figure 2—Vegetation and Tidal Limits as Delimited in *Shaw v. The Queen* [also derived from Porro, A. A. and L. S. Telekey (1972). Marshland title dilemma—A Tidal phenomena. *Seton Hall Law Review*, (3), at p. 333.]

vegetation is typically restricted to areas above spring and storm tide lines. When the limit of vegetation is also delineated from photos for mapping, it can only serve as a rough approximation of the OHWM boundary.

B. Type of Vegetation—Biological Criteria: The OHWM in marshlands is perhaps the most difficult and most contentious tidal boundary survey. Surveyors and government agencies, using either ground survey methods or remote sensing imagery, have attempted to distinguish between vegetation subject to the daily influx of salt water and vegetation only occasionally covered by the high tides. In boundary disputes in New Jersey marshes, it has been found that these biological boundaries differ considerably from boundaries established using tidal data (MHWL) and the latter methodology has been upheld by the courts.[27]

C. Ridges and Berms: Repeated water action can leave ridges and berms that sometimes represent the limits of high tide, but they may correspond to spring tides rather than average tides. In *Shaw v. The Queen*,[28] surveyors delineated a ridge of soil at the edge of the marsh as the boundary, whereas further study showed that this ridge was frequently breached by the incoming tides and therefore did not represent the landward limit of the medium high tides. (See Figure 2.)

D. Lines of Seaweed and Debris: In eastern Canada, debris lines are sometimes used to locate the OHWM. However, as many as four distinct seaweed lines (e.g. representing higher high water spring tides to lower high water neap tides) can be found on many shores. Driftwood or other debris is most commonly deposited by storm tides. The interpretation of such evidence depends on the surveyor's experience and knowledge of local tidal conditions.

OHWM surveys give the approximate location of the high water limit. As changes in the shoreline occur continuously and since the tidal boundary is generally considered ambulatory, it can be argued that such an approximation is sufficient for most purposes. Furthermore, the OHWM is a visible boundary and as a recent New York court noted, it better represents the expectations of upland owners than an invisible MHWL.[29] However, the potential inconsistency in the interpretation of physical evidence and the fact that this evidence frequently does not correspond to the limit of the MHW datum have led to a search for more precise survey methods.

5. MEAN HIGH WATER LINE SURVEYS

Following the *Borax* decision, MHWL surveys have been adopted in many jurisdictions and elsewhere are occasionally used in conjunction with OHWM surveys. MHWL surveys call for establishment of the intersection of the MHW tidal datum with the shore. In the United States, the MHW is precisely defined as:

> *A tidal datum. The average of all the high water heights observed over the National Tidal Datum Epoch. For stations with shorter series, simultaneous comparisons are made with a control station in order to derive the equivalent of a 19-year datum.*[30]

As mentioned in Section 3, no standard definition is available in Canada.

The surveyed location of the MHWL boundary is directly dependent on the manner in which the MHW datum is established at the survey site and on the gradient of the

[27] See, for example, Porro, A. A. and J. P. Weidener [1980]. The Borough case: A classical confrontation of diverse techniques to locate a mean high water line boundary. *Proceedings of the ACSM*, Niagara Falls, NY, October, 1980.

[28] *Supra*, reference 6.

[29] *Dolphin Lane Associates, Ltd. v. Town of Southampton* [1975]. 37 N.Y. 2d 292, 333 N.E. 2d 358, 372 N.Y.S. 2d 52; as reported in Humbrach, J. A. and J. A. Gale [1975]. Tidal title and the boundaries of the Bay: The case of the submerged "High Water" mark. *Forham Urban Law Journal*, 4, pp. 91-128, at p. 105.

[30] Balint, S. J. [1980]. Notice of changes in tidal datums established through the National Tidal Datum Convention of 1980. *Federal Register*, 45(207), pp. 70296-70297.

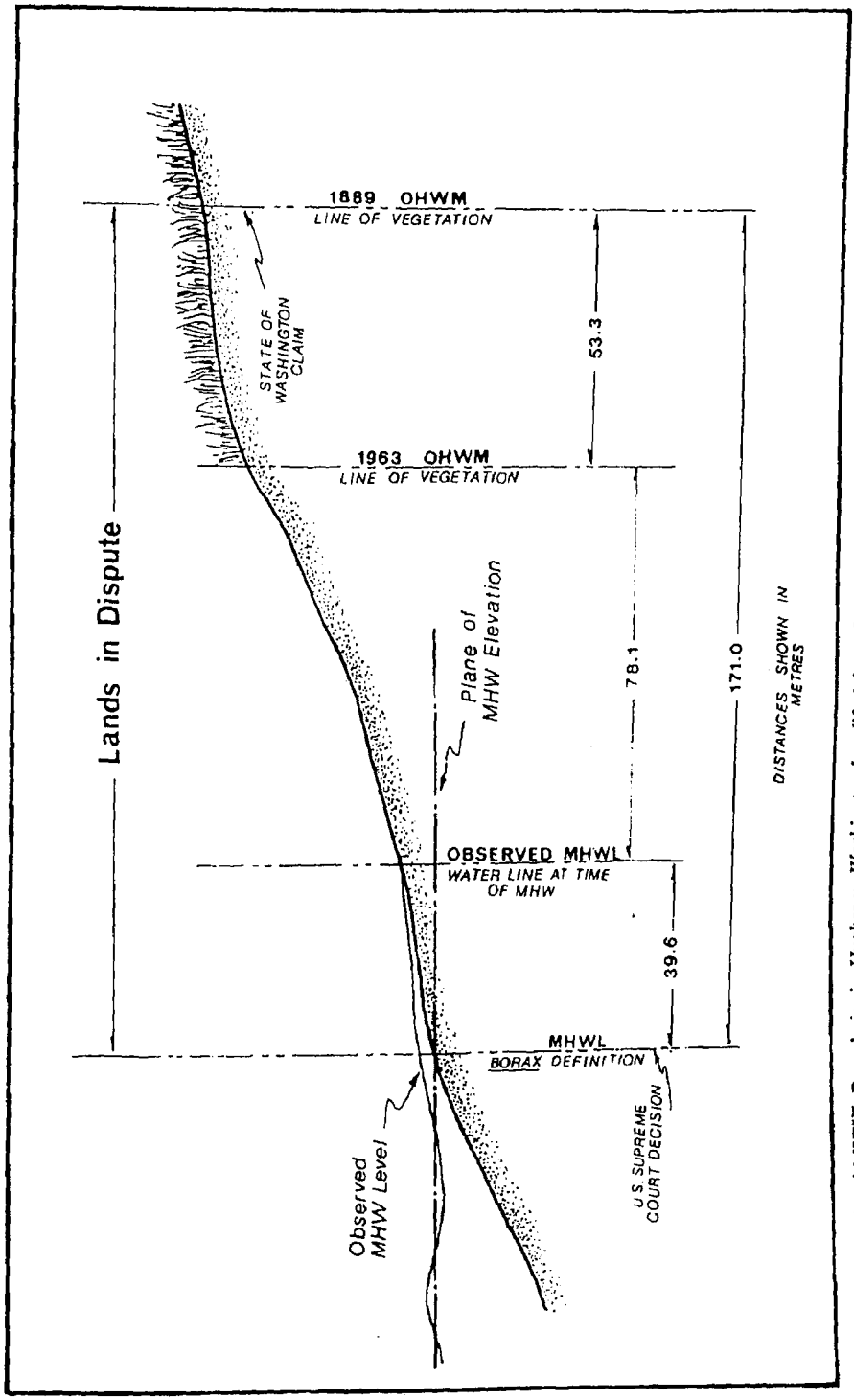

Figure 1—OHWM and MHWL Boundaries in *Hughes v. Washington* [modified from Corker, C. E. (1966). Where does the beach begin and to what extent is this a federal question? *Washington Law Review*, 42, at p. 46]

in most states. Florida and New Jersey have enacted legislation to explicitly redefine the private/state boundary to be the MHWL as given in *Borax*.[20] To support MHWL surveys, the National Oceanic and Atmospheric Administration (NOAA) has implemented an extensive program which has included the densification of tidal stations and the redefinition of tidal datums. Coastal boundary programs in several states complement this program.[21]

The OHWM is by presumption the seaward limit of private rights in Canada. The terms *mean high water mark* or MHWL can also be found in legislation and in parcel descriptions.[22] No definition of a MHW tidal datum is provided in legislation or by the Canadian Hydrographic Service, the agency responsible for tidal data. Furthermore, the tidal information available is based on predictions rather than observations as specified in *Borax*. Therefore, the use of terms implying reference to a precise MHW datum is misleading.

In some jurisdictions, the history of settlement, state policy, and different sources of law have led to other definitions of private/state tidal boundaries. In several American east coast states, such as Maine and Massachusettes, shore properties by presumption extend to low water, variously defined by *ordinary low water mark, mean low line, extreme low water*, or a fixed distance from shore.[23] In Texas, patents obtained under Spanish law are limited by the line of *mean higher high water* and in Hawaii the traditional boundary is the *highest wash of the waves* as indicated by the vegetation line or debris, whichever is further inland.[24] Specific parcels in Canada are also defined by various boundaries, including *ordinary high water spring tides, line of occupation,* and *ordinary low water line.*

4. ORDINARY HIGH WATER MARK SURVEYS

The OHWM has been traditionally interpreted by surveyors in both Canada and the United States as a physical mark on the shore that is assumed to represent the limit of the average or medium tides. A typical definition of the OHWM in survey regulations is the following:

> *the limit or edge of a body of water where the land has been covered by water so long as to wrest it from vegetation, or as to mark a distinct character upon the vegetation where it extends into the water or upon the soil itself.*[25]

Such definitions allow for a wide range of evidence, including the limit of vegetation, discolouration of the soil or rocks, sand berms, and variations in the type of vegetation induced by periodic exposure to salt water. Some of the limitations of the types of survey evidence used include the following:[26]

A. Limit of Vegetation: Surveyors often rely on the edge of vegetation even where this limit does not represent the reach of the average or ordinary tides. On open beaches,

[20] *Florida Coastal Mapping Act of 1974* [1974]. Florida Statutes, c. 177; *New Jersey Coastal Boundary Act of 1982*. Proposed legislation.

[21] See, for example, Cole, G. M. [1978]. Florida's Coastal Mapping Program. *Proceedings of the Coastal Mapping Symposium*. A symposium sponsored by ASP, NOAA and the USGS, Rockville, Maryland, August, 1978, pp. 135-139.

[22] See, for example, *Beaches Preservation and Protection Act*, Statutes of Nova Scotia [1975], c. 6.

[23] Frankel, M. M. [1969]. *Law of Seashore Waters and Water Courses*. Forge Valley, MA: The Murray Printing Co.; also see Graber, P. H. F. [1984]. The law of the coast in a clamshell, Part XVI: The Main approach. *Shore and Beach*, 52(3), pp. 17-20; Curtis [1981], *supra*, reference 3.

[24] Graber, P. H. F. [1983]. The law of the coast in a clamshell, Part XIII: The Hawaii approach. *Shore and Beach*, 51(4), p. 11.

[25] N.S. Reg. 42/79 [1979], pursuant to *Nova Scotia Land Surveyors Act*, S.N.S. [1977], c. 13.

[26] For a further discussion see Nichols [1983], *supra*, reference 6.; Nichols, S. and J. McLaughlin [1984] Tide mark or tidal datum: The need for an interdisciplinary approach to tidal boundary delimitation. *The Canadian Surveyor*, 38(4), pp. 163-176; Doig, J. F. [1978]. Mean high water. *The Canadian Surveyor*, 32(2), pp. 227-236.

the provincial level to plan onshore development related to the petroleum industry. Major planning efforts have been undertaken in British Columbia and in the Canadian Arctic. But for the most part, the projects, laws, and regulations affecting coastal land tenure are a patchwork of partial responses to specific problems.[15]

What has been overlooked in many of land management efforts is the impact that new laws and regulations may have on existing property rights. Boundaries described by environmental or historical criteria, as well as ambiguous terminology, have often created uncertainty and confusion. The costly litigation that follows has made clear definitions of private/state boundaries and consistent methods of surveying these boundaries a priority concern.

3. TIDAL BOUNDARY DEFINITIONS

There are two primary definitions of the private/state tidal boundaries in North America: the *ordinary high water mark (OHWM)* and the *mean high water line (MHWL)*. It can be argued that this distinction is one of semantics because these terms, or variations of these terms, are often used interchangeably within the surveying and legal communities. The distinction, however, has significance when discussing the methods for surveying these boundaries—the OHWM refers to a physical mark whereas the MHWL specifies the intersection of a precisely defined tidal datum with the shore.

The term OHWM is derived from Hale's proposed limit for private ownership. Since Hale used the contradictory words *ordinary or neap tides*, some confusion still exists where the phrase is quoted verbatum. In the 1854 British decision *Attorney General v. Chambers*,[16] these tides were interpreted as the "*medium* tide between spring and neap" and North American courts have generally excluded extraordinary tides. California is an exception where state courts have upheld the neap tide interpretation in some cases.[17]

Borax Consolidated Ltd. v. The City of Los Angeles,[18] a landmark case involving a marshland boundary on a small island in California, revolutionized both the definition and survey of tidal boundaries. The neap tide rule and an OHWM based on vegetation were considered but eventually rejected by the U.S. Supreme Court on appeal. In 1935, this Court found the boundary to be the intersection of the mean high water (MHW) tidal datum with the shore, where that datum was defined as the average of all the high tides based on 18.6 years of tidal observations.

The potential disparity between the OHWM and MHWL definitions can be illustrated by the boundaries disputed in *Hughes v. Washington*,[19] as shown in Figure 1. In this case, the state claimed all tidelands seaward of the vegetation line of 1889. The U.S. Supreme Court dismissed the claim, and defined the boundary as the MHWL as in *Borax*. Two interpretations of the MHWL are illustrated in Figure 1: the first is based on the intersection of a plane at the MHW elevation as determined from a nearby tidal station—the second represents the observed waterline when MHW occurred at the site.

The OHWM definition of the private/state tidal boundary is still used in several American jurisdictions, but since the *Borax* decision, the term MHWL has been accepted

[15] See, for example, Harrison P. and J. G. M. Parkes [1983]. Coastal Zone Management in Canada. *Coastal Zone Management Journal*, 11(1-2), pp. 1-11.

[16] *Attorney-General v Chambers* [1854]. 4 Deg. M. & G. 206; 43 E. R. 486.

[17] See, for example, Shalowitz [1962], *supra*, reference 1, p. 92.

[18] *Borax Consolidated Ltd. v. The City of Los Angeles*. [1935]. 296 U.S. 10.; for a discussion of the case see, for example, Corker, C. E. [1966]. Where does the beach begin, and to what extent is this a federal question? *Washington Law Review*, 42, pp. 33-118; Maloney, F. E. and R. C. Ausness [1974]. The use and significance of the mean high water line in coastal boundary mapping. *North Carolina Law Review*, 53, pp. 183-273; Shalowitz, A. L. [1968]. Tidal boundaries—The *Borax* case revisited. *Surveying and Mapping*, 28(3), pp. 501-509.

[19] *Hughes v. Washington* [1966]. 67 Wash. Dec. (2d) 787; 410 P. (2d) 20.; for a discussion of the case, see Corker, C. E. [1966], *supra*, reference 18.

Province of Prince Edward Island led to a two million dollar claim for compensation and a costly, forty year dispute.[6]

C. Limiting Coastal Development: Most development control regulations are administered by local planning agencies, but several states have created special boundaries to limit coastal land ownership and development. In Florida, for example, where tourist resorts span the shore, the state has implemented a statewide *coastal construction setback line*, 50 feet (15.4 metres) landward of the mean high water line.[7] Reservations of a coastal strip were made in some early grants in Atlantic Canada, such as *ship's rooms* in Newfoundland which discouraged settlement on lands used by the seasonal British fishing fleet in the 17th and 18th centuries.[8] Grants of land in the Canadian northern territories are still subject to 100 foot (30.5 metre) reservations measured inland from the ordinary high water mark.[9]

D. Limiting Private Ownership of Accretion: The doctrine of accretion and erosion, whereby tidal boundaries are considered ambulatory when gradual and imperceptible changes to the coast occur, has been upheld in all North American jurisdictions. There are, however, some differences in application. Artificially caused accretions in California, for example, belong to the owner of the tidelands rather than to the upland owner even when the source of the shoreline change (e.g. a wharf) is located on another property.[10] Canadian law has sometimes been concerned with whether accretion has built up vertically from the bed or laterally from the shore.[11] In New Jersey and Washington, attempts have been made by the states to claim lands seaward of fixed historical boundaries, but such claims have been successfully disputed in the courts.[12]

Recognizing the need to address these and other concerns and recognizing the plurality and inadequacy of existing laws regulating coastal land use, some jurisdictions have begun to implement comprehensive coastal zone management programs. The 1972 *Coastal Zone Management Act*[13] provides federal incentives to American states to develop such programs complementing state and local initiatives. The limits of the coastal zones vary from the entire state, as in Florida, to a narrow strip on either side of the high water boundary as in Washington.[14]

Despite several reports and intergovernmental conferences recognizing the need to co-ordinate activities in Canada, coastal zone management programs are still in the discussion stage. Newfoundland has established a Shore Zone Management agency at

[6] *R. Gordon Shaw v. The Queen* [1980]. 2 F.C. 608; for a discussion of the issues, see Nichols, S. E. [1983]. *Tidal Boundary Delimitation*. Technical Report 103, Department of Surveying Engineering, University of New Brunswick, Fredericton, N.B., Canada.

[7] *Beach and Shore Protection Act.* [1980 Supp.] Florida Statutes c. 161.052(1); as reported in Graber, P. H. F. [1981]. The law of the coast in a clamshell, Part IV: The Florida approach. *Shore and Beach*, 49(2), p. 17 and note 80, p. 19.

[8] McEwen, A. C. [1978] *Newfoundland Law of Real Property: The Origin and Development of Land Ownership*. PhD. dissertation, Faculty of Laws, University of London; parts are summarized in McEwen, A. C. [1978]. Land titles in Newfoundland. *Canadian Surveyor*, 31(2).

[9] *Territorial Lands Act.* R.S.C. [1970], c. T-6, s. 9; as ammended by 1974-75-76, c. 52.

[10] Graber, P. H. F. [1981]. The law of the coast in a clamshell, Part III, The California approach. *Shore and Beach*, 49(2), pp. 22.

[11] *Att. General of the Province of British Columbia v. Neilson.* [1956] S.C.R. 819; 5 D.L.R. 2d 449; reversing 16 W.W.R. 625; [1955] 3 D.L.R. 56; affirming 13 W.W.R. 241.

[12] Porro, A. A. and L. S. Telekey [1972]. Marshland title dilemma: A tidal phenomena. *Seton Hall Law Review*, Vol. 3, pp. 323-348; also see Tell [1982], *supra*, reference 5.

[13] *Coastal Zone Management Act* [1972] 86 Stat. 1280, 16 U.S.C., s. 1451 and ammended [1976] 90 Stat. 1015, 16 U.S.C., s. 1454; as reported in Graber, P. H. F. [1981]. The law of the coast in a clamshell, Part II: The federal government's expanding role. *Shore and Beach*, 49(1), p. 18.

[14] Graber, P. H. F. [1981], *supra*, reference 7; also see [1972] *Shorelines Management: The Washington Experience, Proceedings of Symposium in Seattle Centre, June, 24, 1972*. Seattle: University of Washington Press.

surveys are generally well accepted by the surveying and legal professions and by coastal landowners. Although rudimentary MHWL surveys have been used in some areas, the need to improve survey methods and adopt MHWL definitions and standards is not perceived as a priority. As yet, the costs of providing appropriate tidal data probably outweigh the benefits of improvements.

If and when the need for change arises, the survey profession must be ready to meet the challenge. Surveyors should be aware of the shortcomings of existing methods, as well as means to improve boundary delimitation. Much can be learned from the American experience in adopting standard definitions and in improving MHWL surveys through on-site tidal observations supported by systematic coastal boundary programs. Without consistent definitions and survey standards based on scientific knowledge of the tidal regime and without appropriate tidal information, precise delimitation of tidal boundaries will continue to elude the surveyor.